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THE ANATOMY OF SOME SEXUALLY MATURE SPECIMENS OF DERO LIMOSA LEIDY.[1]

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Introduction

Ecology. The material on which this paper is based was collected during the summer of 1921 at the Biological Station of the University of Michigan, on Douglas Lake, Michigan. The particular locality was a small bog draining into Burt Lake, about four and one half miles from the Station. A thick mat of algae taken from a plank at the surface of the water proved to be especially rich in the following genera of Naididae: *Nais*, *Chaetogaster*, *Pristina*, and *Dero*. The families Lumbriculidae and Enchytraeidae were represented by a number of specimens. Plankton taken from the water near by contained specimens of the genera *Slavina*, *Stylaria*, *Nais*, *Dero*, and *Pristina*.

During the examination of the algae it was frequently noticed that a number of worms of the same species would be found close together. Notes made at the time showed that four sexually mature specimens of *Dero limosa* were thus found in close proximity. At other times *Pristina* would be represented in great abundance. Five specimens belonging to the genus *Nais* were taken from an area about two inches square and were the only specimens of the genus found in the algae. Only one or two specimens belonging to the genus *Nais* were taken from the plankton. So commonly was the grouping of worms of the same kind observed, that when one of a particularly desirable type was located, the algae of the immediate vicinity was examined with special care.

Technique. Specimens of *Dero* were found to be the most difficult of any of the worms encountered, to kill and fix for histological study. Anesthesis with chloretone often resulted in the death and maceration of the posterior part of the worm before the anterior ceased to move or came sufficiently under the influence of the drug to prevent bending and distortion when subjected to the killing fluid. A concentrated aqueous solution of corrosive sublimate was used as a fixing fluid. The specimens sectioned were cut transversely, 6 μ in thickness, and stained with Delafield's haematoxlin and eosin. Mounts, in toto, were stained in borax carmine and cleared in oil of wintergreen.

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[1] Contribution from the Zoological Laboratory of the University of Illinois, No. 212 and from the University of Michigan Biological Station.

Identification. Seven sexually mature and numerous immature specimens of *Dero limosa* Leidy were taken from the algae referred to above during the first two weeks of August, 1921. The determination of the species proved a little difficult since living specimens not anesthetized were constantly in motion, and, when anesthetized or killed for preservation, were usually found to have completely closed the branchial pavilion. The gill arrangement seems, however, identical with that of the above named species as described by Michaelsen ('00, '03, & '09) and others. Examination of sections of the closed pavilion reveals the fact that the lateral portions of the lip, which are carried medially in the process of closing, may easily be mistaken for a third pair of gills on the ventral portion of the structure, since they are intimately associated with the true gills in position and have similar cell arrangement (fig. 16).

Since the only descriptions found of sexually mature specimens belonging to the genus are those given by Michaelsen ('00) for *D. perrieri* and *D. multibranchiata*, and by Walton ('06) in his general description of the genus, it seems desirable to give a rather extended account of the new material mentioned above. The descriptions of the sex organs as given by Michaelsen are brief and are here quoted for comparison.

D. perrieri, "1 Paar Samentrichter im 5. Segm.; Samenleiter allmählich in die drüsenlosen Atrien übergehend. 1 unpaariger Eiersack. Samentaschen im 5. Segm., mit scharf abgesetztem, ziemlich kurzem, tonnenförmigem Ausführungsgang."

D. multibranchiata, "Unpaariger Samensack vom 5. Segm. nach hinten gehend. Ovarien (Eiersäcke?) im 7. Segm."

Length and Number of Somites

The length of preserved sexually mature specimens varied from 5 to 10 mm. and the total number of segments from 40 to 55. Immature specimens showed an equal range of variation in length and contained from 40 to 62 somites; those with one or two budding zones containing from 50 to 59.

Setae

In respect to the setae, the sexually mature specimens differ from the immature only in the entire absence of ventral bundles in the 6th somite in contrast with the occurence of special or genital setae in *Nais obtusa* and a number of other species described by Piguet ('06 & '09). The dorsal bundles, which begin on the 6th somite in both mature and immature specimens, have been found to contain one long capilliform and one short, slightly cleft, biuncinate seta in each of the bundles examined (fig. 13). The long capilliform setae are about equal in length to the diameter of the body, and are without serrations. The biuncinate setae extend but little beyond the surface of the body, and are more or less curved and somewhat tapered distally. Their distal portions are much stouter than figured by Michaelsen ('09) and by Bousfield ('87), and the tips of the teeth are not sharp pointed but slightly rounded. One biuncinate seta of a sexually mature specimen was found to be somewhat smaller in diameter and to have a slight nodulus. Piguet ('09) says that mature specimens of the genus *Nais* lose the setae of the dorsal bundles in the clitellar somites, but such is not the case in *D. limosa.*

The ventral bundles (fig. 9–12) contain from 2 to 5, in the majority of instances 3 or 4, biuncinate setae. The distal tooth, or the one farthest from the nodulus, is about equal in length to the proximal, or but slightly longer. The teeth are usually sharp pointed, though occasionally the proximal one is thickened and round pointed. They often appear to have round tips due to their being turned so that an exact lateral view is not obtained. Each of the ventral setae is provided with a well defined nodulus.

The ventral setae of somites 2–5 are longer than those from the remainder of the body, in both mature and immature specimens. Setae from each of the somites 2–5 were measured and averaged for each specimen with the result that the averages varied from 120μ to 160μ. Averages obtained in like manner from a number of somites posterior to 6 varied from 80 to 100μ. The extreme difference between the averages so obtained for any specimen was 65μ, the measurements being 95μ to 160μ. Definite ratio relations have been noted between the portions of the setae proximal and distal to the noduli in particular parts of the worm. The portions of the setae distal to the noduli in somites 2–5 are usually about equal in length to the proximal parts but may be as much as 1.5 times as long, while the distal portions of setae in somites posterior to 6 are only .6 to .8 as long as the proximal.

The Reproductive Organs

Clitellum. This organ extends from the anterior part of the 5th somite almost to the setae of the 8th (fig. 1, cl.). On the ventral side it begins just back of the openings of the spermathecae, but dorsally farther forward. In life the clitellum is yellowish or cream colored, and, when sectioned, is found to be made up of a single layer of large columnar cells containing large globules of a substance, which is probably the secretion that later forms the cocoon, and relatively small nuclei irregularly distributed in the cells.

Spermathecae. These are conspicuous paired organs almost filling the ventral two thirds of the 5th somite (fig. 1–3, spm.) The upper part is a relatively thick walled sac with deeply staining, irregularly arranged nuclei, and well filled with a compact mass of sperm cells indicating that copulation has taken place. The duct arises a little laterad of the most ventral portion of the sac and extends directly to the body wall where it turns directly posteriad, a very short distance, and opens on the surface through the pore slightly anteriad and laterad of the ventral seta bundle of the same side of the somite (fig. 2 & 3). In one specimen the duct passes almost directly to the pore. The walls of the duct are thickly set with nuclei of about the same size as those of the sac. Dorsal to the spermathecae there is a quantity of sperm cells in the body cavity.

Sperm ducts. A pair of sperm ducts lie in the 6th somite and have their funnels in the posterior part of the 5th. Each of the pair consists of four portions, (1) the spermiducal funnel, (2) a duct joining the funnel to the atrium, (3) the atrium, and (4) the duct connecting the atrium with the hypodermal invagination. The spermiducal funnels are found in the ventral posterior part of the 5th somite anterior to septum 5/6. They are shaped as if the distal end of the duct had been split on the dorsal side and the lateral portions flattened out in the process of formation. The part of the duct between the funnel and the atrium tapers posteriorly, bends abruptly upon itself (figs. 1 & 7), and extends anteriorly to its point of union with the atrium, on the median anterior ventral surface of the latter. The atrium is a cylindrical sac occupying much of the anterior ventral portion of the corresponding half of the 6th somite. The walls are relatively thick and are made up of a single layer of large irregular cells containing large vacuoles. The duct leading from its posterior end is short and opens into a conspicuous invagination of the hypodermis on the ventral wall of the body. In one specimen one atrium was displaced so that it lay dorsad of the nerve cord in the median line of the body.

Spermaries. Nothing was found which could be identified as such. This fact is probably due to the advanced stage of sexual maturity of the specimens, as the sperm sac and spermathecae were filled with sperm cells. When developed, they should be present on the posterior side of septum 4/5, since sperm cells were found above the spermathecae, and the sperm sac extended posteriad from the 5th somite.

Sperm sac. The sperm sac is a posterior evagination of septum 5/6, and extends a short distance posteriad of the setae of the 7th somite in one specimen.

Oviducal pores and funnels. The pores are paired and are in the posterior part of the 6th somite about midway between a line joining the ventral seta bundles and one joining the dorsal seta bundles of the 6th and 7th somites (figs. 1 & 14). No distinct funnels could be identified comparable with those figured and described by Piguet ('09) for *Nais obtusa,* although there appeared to be several cells on each side which might properly be interpreted as belonging to a funnel since they are sharply differentiated from the clitellum (fig. 15). The cells of the clitellum are so graded in length as to form a distinct depression with the funnel cells at the base. The paired funnels are in the same relative position as those of *Nais obtusa.* The lumen of the pore could not be located, probably because of the thickness of the transverse sections, and, for the same reason, the opening in the muscular layers was not observed. The muscular layers were found separated from the pore cells in that region. The funnel and pore would no doubt be much more conspicuous at the time of emission of the eggs.

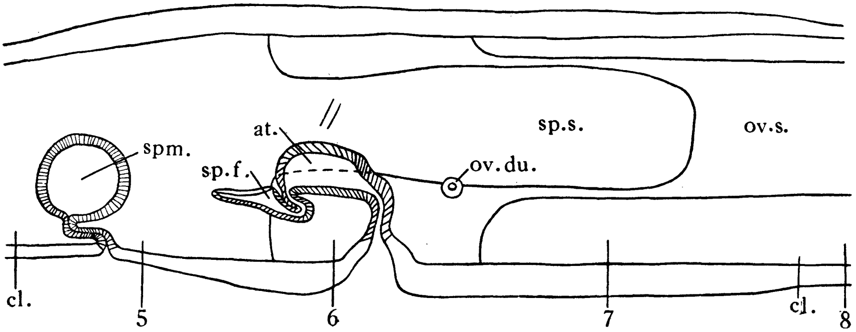

FIG. 1. Diagram showing the general plan of arrangement of the sex organs in somites 5 to 8. Reconstructed from camera lucida outlines of serial transverse sections. Lettering as for other figures. The numbers indicate the position of the setae bundles. 120X.

Ovisac. (fig. 1). The ovisac is formed by septum 6/7 and extends posteriad, in one specimen through the 12th somite, in another, just beyond the seta bundles of the 9th. Its extent is no doubt dependent upon the quantity of ova present. It almost fills the body cavity for the major part of its length, and is distended with a granular appearing material which stains pink with eosin, but contains no ova. The sperm sac lies within its anterior portion.

Ovaries. No ovaries could be found. They should be located on the posterior side of septum 5/6 since the ovisac extends posteriad from 6 and the oviducal pore is in the posterior part of this somite (fig. 1). Their absence is no doubt due to the advanced stage of development of the specimens. The absence of ova and the presence of abundant sperm cells suggests the possibility that an interval of time elapses between the functioning of the spermaries and ovaries. However this does not seem probable because of the very extensive development of the ovisac. It seems more probable that ova have occupied the latter and have been discharged.

Piguet ('06) refers to the appearance of gonads as follows: "Michaelsen suppose que, chez les Naïdidées, les gonades disparaissent entièrement avant le développement des autres organes génitaux; cela est sans doute vrai en général, mais il pourrait y avoir là une exception. Frank Smith (1896, Pl. 35, fig. 4, t.) figure un reste de testicule chez *Pristina Leidyi*." In several mature specimens of *Paranais uncinata* Piguet has observed vestiges of ovaries. It seems, therefore, that there are individual exceptions, but the few observations that have been possible upon *Dero limosa* indicate that gonads are developed only during the period of production of the germ cells.

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ABBREVIATIONS

at.	Atrium	*nc.*	Nerve cord
at. 1	Posterior end of atrium	*ov. du.*	Oviducal funnel and pore
b. l.	Borders of dorsal lip	*ov. s.*	Ovisac
cl.	Clitellum, in fig. 1 the extent of the organ is indicated	*sp.*	Sperm cells
		spm.	Spermathecae
du. s.	Duct of spermatheca	*sp. du.*	Sperm duct
gil. 1	True gills	*sp. du. 1*	Sperm duct opening into atrium
gil. 2	Secondary gills	*sp. du. 2*	Sperm duct in transverse section at its bend
hyp.	Hypodermis		
int.	Intestine	*sp. f.*	Spermiducal funnel
mus.	Muscular layers	*sp. s.*	Sperm sac

DESCRIPTION OF FIGURES

FIG. 2. Transverse section in the 5th somite showing spermathecae. 120X.

FIG. 3. Portion of left spermatheca, its duct and adjacent body wall in transverse section. 270X.

FIG. 4. Transverse section of spermiducal funnel with sperm cells. 270X.

FIG. 5. Transverse section of spermiducal funnel posteriad of section represented in fig. 4. 270X.

FIG. 6. Transverse section of sperm duct and anterior end of atrium at the point of entrance of the duct. 270X.

FIG. 7. Transverse section of the left ventral portion of a specimen at the point where the sperm duct bends anteriad. 270X.

FIG. 8. Transverse section of the left ventral portion of the same specimen, as represented in the preceding figures, at the point where the hypodermal invagination receives the sperm duct. 270X.

FIG. 9. Left ventral setae bundle of the 7th somite. 270X.

FIG. 10. Left ventral setae bundle of the 30th somite. 270X.

FIG. 11. Left ventral seta of the 2nd somite. 270X.

FIG. 12. Left ventral seta of the 3rd somite. 270X.

FIG. 13. Right dorsal setae bundle on the posterior half of a specimen. 340X.

FIG. 14. Diagram showing the position of the oviducal funnels. The position of the setae of the 7th somite is shown, as obtained by superimposing the sections containing them (21 sections posteriad) upon the outline of the sections containing the funnels, by means of a camera lucida. 120X.

FIG. 15. Diagram showing the differentiation of the oviducal funnel from the clitellum 270X.

FIG. 16. Transverse section of the closed branchial pavilion. 150X.

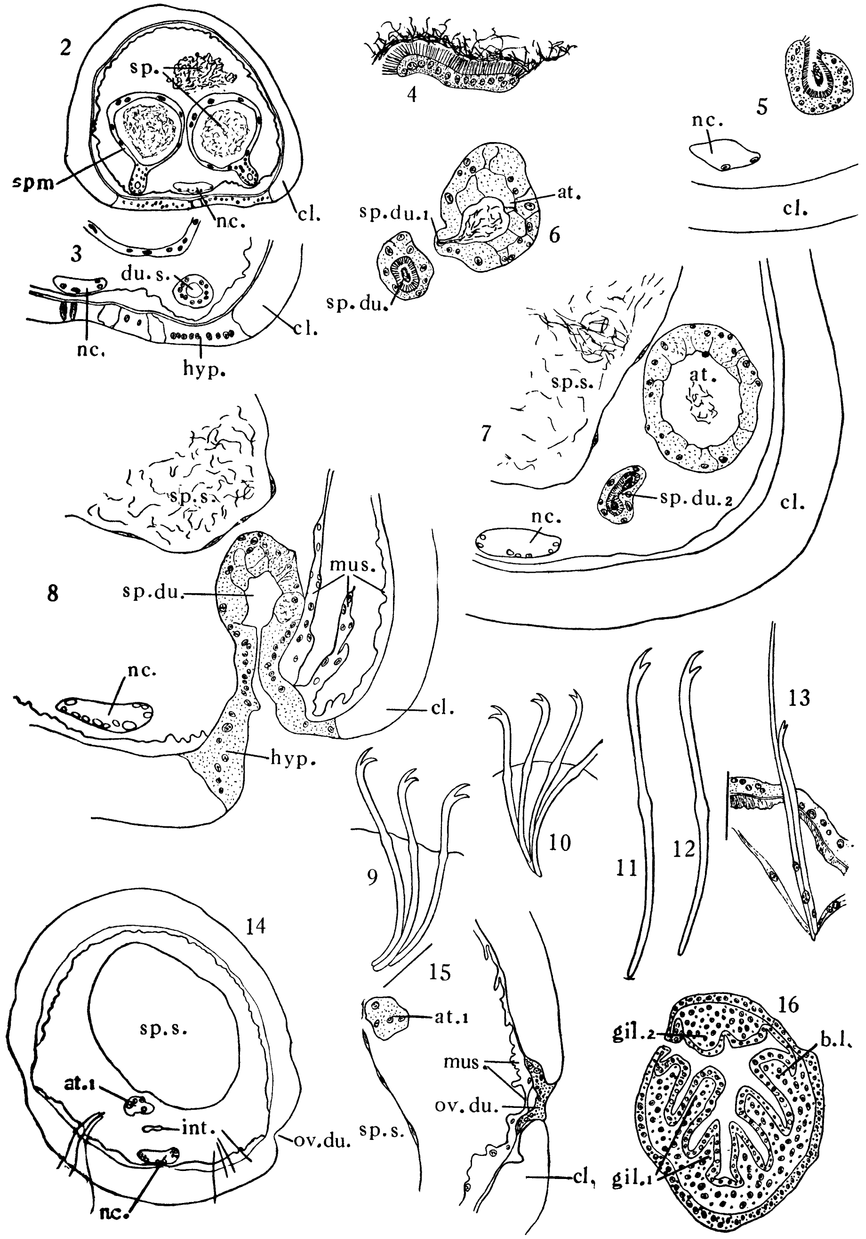
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PLATE XVI